PROTECTIVE IRRIGATION WORKS,

RAJPUTANA.

KADMALI PROJECT,

NIMBAHERA PARGANAH,

TONK STATE.

1905.

INDEX.

ABSTRACT ESTIMATE OF COST.

PLANS.

KADMALI PROJECT,

NIMBAHERA PARGANAH, TONK STATE.

References.—Para. 55, Appendix H; and Para. 7 (*a*) of Appendix I of Report on Irrigation in the Tonk State.

REPORT.

Project described.

After the visit of the Irrigation Commission to Rajputana, and on their recommendation, the Government of India sanctioned a grant for the preparation of certain selected projects in those States which had no Engineers of their own, and in Tonk, Mr. Wakefield, who was Superintendent of Revenue in that State, but an Engineer by profession, kindly undertook the supervision of this work.

The largest of the projects prepared by Mr. Wakefield was for constructing a very large storage reservoir on the Kadmali River, near Barli Ghataki, about 2½ miles north-east of Nimbahera Town. The Kadmali is the principal river in Nimbahera, as with its tributaries it carries away nearly all the drainage of the Parganah.

The following were the details of the Project:—

(*a*)	Catchment Area	149 square miles.
(*b*)	Run-off	20 per cent. of average rainfall of 25 inches.
(*c*)	Water available for Storage ...	1,738 m.c.ft.
(*d*)	Proposed capacity of Reservoir at full supply level ...	1,461 m.c.ft.
(*e*)	Commanded Area	13,514 acres on the left bank within the Parganah and up to the Mewar boundary.

Surveys were prepared, and plans partly drawn out, but no detailed estimate was worked out, but as it was proposed to have Weir level 53 ft. above the river bed, and the Dam would have been three miles long, the cost would not have been less than three lacs, and would probably have been more.

The site was inspected by the Consulting Engineer for Irrigation in Rajputana in November 1903, and for the reasons stated in his Inspection Note (Appendix H of Report on Irrigation in the Tonk State), he was not satisfied that the Project was a safe and sound one, nor did he feel disposed to recommend it, but as the river continues to run for some

months after the rains in years of ordinary rainfall, and the rock crossing in the river bed formed an excellent site for constructing a Weir, the Consulting Engineer thought better use of the water could be made by constructing a Weir across the river, and leading the water by a canal on to the land, where it could be used for direct irrigation, or for supplying small Tanks constructed at suitable places for the storage of water to irrigate the land each commanded.

Surveys for this revised scheme have therefore been prepared, and this estimate, with plans, provides for carrying out what the Consulting Engineer proposed.

Site for Weir.

2. There is good rock across the river bed and stretching on the left bank, for 1,800 r.ft. in length (see Plan No. III.), and on this it is proposed to construct the Weir.

The right bank of the river is hard moorum, and rises almost vertically to a height of 30 ft. above the bed, and to prevent the water cutting round and behind the Weir, it is proposed to build a masonry Wing-wall up to the level of the top of this bank, with a Core-wall 100 ft. in length in continuation of the Weir, running into the right bank.

Catchment Area; Maximum Discharge; Length of Weir.

3. The catchment area of the river at the site of the proposed Weir is 149 square miles, and from this the maximum discharge (by Dicken's Formula) is 34,831·5 cusecs. The effective length of the Weir is 1,800 r.ft., the clear length between extreme points being 1,900 r.ft.; with this effective length the maximum discharge will pass over the Weir with a head of 3·11 ft.

Weir.

4. R. L. 96·90 being the level of the river bed at its lowest point on the line for Weir, it is proposed to make R. L. 120 the crest level of Weir; this is practically the level of the rock ledge on the left bank. The flood level will therefore be R. L. 123·11; and the top of the masonry Wing-wall on the right bank will be R. L. 127; and this nearly corresponds with the level of the top of this bank.

The Weir will be of masonry, with foundations countersunk 2 ft. into the rock; the thickness at crest is 3 ft.; and at any point below fixed by the formula $T = \frac{d}{\sqrt{g}}$ where "d" is the depth below flood level and "g" the specific gravity of masonry 2·24. The Weir has a front batter of 1 in 12.

Wing-Wall.

5. The Wing-wall on the right bank is 2 ft. thick at top, $\frac{H}{3}$ is the thickness at any point below, and the foundations will be countersunk at least 2 ft. into the rock.

In elevation, starting from bed level of the nullah, the Wing-wall has slopes of 2 to 1, with steps on the top, each with 1 ft. rise and 2 ft. tread; to crest level of Weir (R. L. 120), then a recess 5 ft. wide from which the wall rises another 7 ft. in height, with slopes of 3 to 1, the top width being 10 ft.

Core-Wall

6. The Core-wall runs into the right bank behind the Wing-wall for 100 ft in length ; it is 1½ ft. thick at top, increasing 6 inches in thickness at every 5 ft. depth by 3-inch offsets on either side; and the foundations will be taken down to and countersunk into the rock throughout.

Water available for Irrigation.

7. A section was taken up the bed of the main river, and also of the tributary nullah, which joins the former just above the site of the proposed Weir; and cross sections of both streams at every 1,000 ft. were also taken.

From these, the water stored up to crest level of Weir works out to 50·44 m.c.ft. It is proposed to make bed level of canal R. L. 116, or 4 ft. below crest of Dam ; and the water stored up to this level is 30·21 m.c.ft. (see Plan No. IV). We shall therefore have 20·23 m.c.ft. of water stored in the river available for irrigation. To this must be added the natural flow of the river.

In years of normal rainfall the river runs averaging 1 ft. in depth over the rocky bed of the river—which is about 50 ft. wide from bank to bank at this depth—up to end of November ; and after that till the end of February it runs with about half that depth.

The fall of the river above the site is 7½ ft. in the mile ; and by "Kutter's" formula these data give a theoretical discharge of 74·5 cusecs up to end of November, and an average of 37 cusecs after that till February.

Land available for Irrigation.

8. Starting with bed level R. L. 116, the canal has been set out with a fall of 1 ft. per mile for 10 miles (see Plan No. II), when the Mewar boundary is reached, and it tails into a tributary nullah of the Gameri River, the latter having been joined by the Kadmali three miles below the site of the Weir.

Irrigation will begin from the third mile, and from that point to the end of the canal the land commanded is 7½ square miles, or 4,800 acres.

The plain is rich mal land, but allowing for broken ground, nullahs, etc., we shall be on the safe side if we assume that only three-quarters of this area, or 3,600 acres, is available for irrigation.

Water required for Irrigation.

9. To irrigate 3,600 acres the canal must discharge 360 m.c.ft. (allowing 100,000 c.ft. per acre) during the four months of the Rabi Irrigation season.

For the first month, as the demand for irrigation is simultaneous, it should be capable of giving a first watering of 1 ft. in 30 days' continuous flow to the whole area commanded, or—

$$D = \frac{3,600 \times 43,560}{30 \times 24 \times 60 \times 60} = \frac{156,816,000}{2,592,000} = 60{\cdot}5 \text{ cusecs ; or } 156{\cdot}82 \text{ m.c.ft.,}$$

and for the remaining three months it must discharge the balance required during the irrigation season, or—

$$\frac{D = (360 - 156{\cdot}82)}{3 \times 2{\cdot}592} = \frac{203{\cdot}18}{7{\cdot}776} = 26{\cdot}12 \text{ cusecs.}$$

From this it is evident that in normal years of rainfall the natural flow of the river—which is calculated at 75 cusecs for the first month, and

32 cusecs afterwards—will be sufficient for our requirements; and the 20 m.c.ft. of water stored in the rains by the Weir will be in excess, but will help in case the natural flow fails.

Section of Canal.

10. To discharge 61 cusecs, the maximum required, with a fall of 1 ft. per mile, the canal must have a bed width of 7 ft., depth of 4 ft., and side slopes of 1 to 1.

It is proposed to have the canal in cutting throughout.

Head Works of Canal.

11. The canal starts in rock cutting 8 ft. in depth, at a point 400 ft. from the west end of the Weir, where the ground level is R. L. 124 or 1 ft. above flood level.

A masonry wall will be built across the entrance of the canal with two arched openings 4 ft.$^{H.}$ by 2½ ft.$^{D.}$, over which regulating gates, with counterweights to facilitate raising, are fixed (see Plan No. V).

The gates are lowered or raised as required to regulate the supply; and each gate when open full will discharge 66 cusecs, so that one gate is really sufficient for our requirements.

Escapes.

12. The line of the canal is across the drainage of the country, and three nullahs, the Mothan, Arnia and Okhlia are crossed, at each of which escapes are provided to pass the flood water in the rains. Plan No. VI shows what is proposed. There will be a masonry Core-wall across the canal, with openings which will be closed by wooden planks during the rains to prevent the flood water of the nullahs passing down and damaging the canal; and across the nullah itself on the down stream side a masonry wall of the length required to pass the maximum flood for the catchment intercepted, forming an escape, with an apron of dry stone 10 ft. wide in rear, the canal banks on either side this Weir being pitched to prevent damage by the flood water.

The foundations of the masonry wall forming the escape are taken down 2 ft. below the level of the bed of canal; and on the top of the wall, piers 2 ft. wide and 1 ft. high and 4 ft. apart, are provided, with grooves into which planks can be put during the irrigation season, to prevent the canal water when the canal is running full spilling over the escapes.

Storage Tanks.

13. No suitable sites for constructing storage tanks were found on the line of the canal, except on the Okhlia Nullah, where it is proposed to make a small Tank with a capacity of 21 m.c.ft.

The Dam will be entirely of earthwork, and a Sluice of the ordinary country type for irrigating the land below will be provided.

Plan No. VII shows what is proposed. The country on either bank of the Mothan Nullah, the first crossed, is too flat for constructing a Tank, and in the case of the Arnia Nullah, if a Tank was constructed below Tilikhera, where there is a suitable site between two hillocks, valuable well lands would be submerged.

14. The following is the Abstract Estimate of Cost:— Abstract Estimate of Cost.

		Rs.
(1)	Weir and Wing-wall across Kadmali River	28,564
(2)	Head Works	402
(3)	Canal	28,679
(4)	Escapes	1,575
(5)	Road Crossings	600
(6)	Okhlia Tank	7,384
(7)	Contingencies	3,360
	Total ...	Rs. 70,564

15. Provided the rains are normal to give all the water required, and provided there are sufficient cultivators, the 3,600 acres commanded could be taken up, and the revenue, at Rs. 3-8 per acre (the difference in assessment between irrigated and unirrigated land in the Parganah), would amount to Rs. 13,600, or over 19 per cent. profit on the estimated cost. Revenue.

This is taking the most favourable view, but if only quarter of the land available, or 900 acres, were irrigated, a revenue of Rs. 3,150 would be realized, giving a profit of nearly 4½ per cent. Even in years of exceptional scarcity, when the maximum amount of water available would probably be only that stored in the river above canal bed, or 20 m.c.ft., sufficient for 200 acres, a revenue of Rs. 650 would be realized, or nearly 1 per cent profit.

The above shows what a great opportunity there is for making use of the water of the Kadmali River—which at present flows away each year and is lost—at comparatively little cost, to the great advantage of the State.

16. The surveys were made by Sub-overseer Sham Singh, and the Plans and Estimate have been worked out by Overseer Ramchander under the directions of the Superintending Engineer, Protective Irrigation Works, Rajputana. Preparation of Project.

SPECIFICATION.

17. All the dimensions of the work are given in the Plans and Estimate, which are to be strictly adhered to. Dimensions.

18. The centre line and the side slopes to be marked out with trenches 1 ft. broad and 1 ft. deep, showing permanently the inner and outer slopes, the bed width of canal, and the width of the top of the embankment. Marking out.

19. The embankment will be carried out in layers not exceeding 9 inches in thickness, carefully consolidated. All the layers will be laid concave, that is lower in the centre. No clods of earth should, on any account be allowed in the embankment. Earthwork.

Canal.

20. All the cutting to be done as per section, with required slope in bed. The earth excavated to be used in forming the embankment on the right bank of the canal.

Masonry.

21. The masonry of Weir, Wing-wall, Head Works, Escapes, etc., to be of rubble stone set in lime mortar ; only hard and durable stones to be used, and the masonry to be kept wet during construction. All the stones to be hammer-dressed and to break joint in the same as well as in the successive courses.

All stones are to be laid on their natural beds ; where there is batter the beds of the stones are to be at right angles to the batter. Hollows between the larger stones to be filled in with smaller ones completely embedded in mortar. No empty hollow to be left nor spaces filled wholly with mortar or rubbish where pieces of stones ought to have been inserted.

The faces of the masonry in contact with the earth to be left quite rough, and those remaining exposed to be smoothed and pointed with lime mortar.

Lime Mortar

22. The lime to be of good hard kunkar burnt in wood fuel, cow-dung to be only used for igniting the fire, and never to exceed more than 1 per cent. The mortar to consist of 1 part of lime to 1½ parts clear sand or surkee.

F. ST-G. MANNERS SMITH,
SUPERINTENDING ENGINEER,
Protective Irrigation Works, Rajputana.

AJMER,
9th August 1905.

ABSTRACT ESTIMATE OF COST.

Kadmali Project, Nimbahera Parganah, Tonk State.

Quantity or No.	Items.	Rate.	Per	Amount.	Total.	
		Rs. A.		Rs.	Rs.	Rs.
	(1) WEIR AND WING-WALL ACROSS THE RIVER.					
45.719 c.ft.	(*a*) Excavation in rock ...	4 0	100 c.ft.	1,829		
44,736 „	(*b*) „ in earth ..	6 0	1,000 „	268		
165,082 „	(*c*) Masonry	16 0	100 „	26,413		
10,850 „	(*d*) Earthwork in rear of Wing-wall	5 0	1,000 „	54		
					28,564	
						28,564
	(2) HEAD WORKS.					
216 c.ft.	(*a*) Excavation in earth ...	6 0	1,000 c.ft.	1	1	
601 „	(*b*) „ in rock ...	4 0	100 „	24	24	
1,089 „	(*c*) Masonry	16 0	100 „	174	174	
10 „	(*d*) Arch Masonry	18 0	100 „	2	2	
8 „	(*e*) Stone Slabs	2 0	c ft.	16	16	
	(*f*) Woodwork—					
28 s.ft.	Gates	2 0	s.ft.	56		
2 No.	Pulleys, with stand ..	5 0	each.	10		
					66	
	(*g*) Ironwork—					
40 r.ft.	Chain, with hooks	2 0	r.ft.	80		
21 „	Rails (metre-gauge, $3\frac{3}{8}$ ft.)	1 0	„	21		
10 „	Girder	1 0	„	10		
21 „	Rod Iron $1\frac{1}{4}''$ dia.	0 6	„	8		
					119	
						402
	(3) CANAL.					
601,250 c.ft.	(*a*) Excavation in rock ...	3 0	100 c ft	18,037		
2,660,500 „	(*b*) „ in earth ...	4 0	1,000 „	10,642		
					28,679	
	Carried over ...	...	...	...	28,679	28,966

Quantity or Number.	Items.	Rate.	Per	Amount.	Total.	
		Rs. A.		Rs.	Rs.	Rs
	Brought over ...	...	...	...	28,679	28,966
	(*e*) Escape (A) at Mothan Nullah.					
4,126 c.ft.	Excavation	6 0	1,000 c ft.	25		
2,629 „	Masonry	16 0	100 „	421		
1,348 „	Paving and Pitching	3 0	100 „	40		
1,750 „	Earthwork	4 0	1,000 „	7		
22 „	Woodwork	3 0	c.ft.	66		
					559	
	(*d*) Escape (B) at Arnia Nullah.					
3,224 c.ft.	Excavation	6 0	1,000 c.ft	19		
2,095 „	Masonry	16 0	100 „	335		
1,198 „	Paving and Pitching	3 0	100 „	36		
1,750 „	Earthwork	4 0	1,000 „	7		
37 „	Woodwork	3 0	c.ft.	111		
					508	
	(*c*) Escape (C) at Okhla Nullah.					
	Same as Escape (B)	...	...	508	508	
3 No.	(*f*) Road Crossings	200 0	each	600	600	
						30,854
	(4) OKHLIA NULLAH.					
1,342,000 c.ft.	(*a*) Embankment	5 0	1,000 c.ft.	6,710		
	(*b*) Sluice.				6,710	
3,182 c ft.	Excavation	4 0	1,000 c.ft	13		
1,066 „	Concrete	10 0	100 „	107		
2,851 c ft.	Masonry	16 0	100 c ft	456		
377 „	Arch Masonry	18 0	100 „	68		
991 „	Pitching	3 0	100 „	30		
					674	
						7,384
	Total ...	...	...	...	...	67,204
	Contingencies	5 0	cent.	...	...	3,360
	Grand Total ...		...	...	...	70,564